FUNCTIONAL OUTCOME OF ANTERIOR CERVICAL DECOMPRESSION AND FUSION WITH LOCKING ANTERIOR CERVICAL PLATE
- A SHORT TERM FOLLOW UP STUDY

Dissertation submitted for

M.S DEGREE EXAMINATION
BRANCH - II ORTHOPAEDIC SURGERY

Department of Orthopaedics and Traumatology ,
Thanjavur medical college ,
Thanjavur .

TAMILNADU Dr .M.G.R . MEDICAL UNIVERSITY,
CHENNAI , TAMIL NADU .
MARCH 2008

Contents

CERTIFICATE

This is to certify that **DR.N.BALASUBRAMANIAN,** postgraduate (2005-2008) in the Department of Orthopaedics and Traumatology, Thanjavur Medical College and Hospital, Thanjavur, has done this dissertation on **FUNCTIONAL OUTCOME OF ANTERIOR CERVICAL DECOMPRESSION AND FUSION WITH LOCKING ANTERIOR CERVICAL PLATE --** under my guidance and supervision in partial fulfilment of the regulation laid down by the TamilNadu DR.M.G.R. Medical University, Chennai for MS (Orthopaedics) degree examination to be held on March 2008.

PROF . DR R.RATHINASABAPATHY
M.S . Ortho , D.Ortho
Professor and Head of the Department,
Department of Orthopaedics and Traumatology,
Thanjavur Medical College and Hospital,
Thanjavur

ACKNOWLEDGEMENT

I owe my sincere and grateful acknowledgement to my beloved Chief, ***Prof. Dr.R.Rathinasabapathy M.S.Ortho., D.Ortho.,*** *Professor and Head of the Department of Orthopaedics and Traumatology, Thanjavur Medical College and Hospital for his kind help, encouragement and invaluable guidance rendered to me in preparing this dissertation*

I am grateful to my beloved teacher ***Prof.Dr.M.GulamMohideen M.S.Ortho., D.Ortho.,*** *for his constant help, advice and guidance rendered to me in preparing this dissertation*

I express my gratitude to ***Prof.Dr.K.Anbalagan M.S.Ortho., D.Ortho.,*** *for his help and motivation during this study*

I sincerely acknowledge and owe much to ***Dr .V . Sundar Mch .,***

Dr.R.Elangovan MS.,Mch *for his suggestions, untiring help and guidance given to me in every stage of this study*

I sincerely acknowledge and owe much to ***Dr.S.Kumaravel M.S.Ortho., D.Ortho.,*** *for his suggestions, untiring help and guidance given to me in every stage of this study*

I thank my teachers ***Dr.A.Bharathy, Dr.P.Venkatesan, Dr.M.S.Manoharan, Dr.V.Jeyabalan, Dr. D.Thirumalai Pandiyan, Dr.R.Vasantharaman, Dr .A.Thiruvalluvan , Dr. Mathiyas Arthur, Dr.C.Ramasamy*** *and my colleagues for their help and motivation in doing this study*

My sincere thanks to the ***Dean, Thanjavur Medical College and Hospital, Thanjavur*** *for permitting me to utilize the hospital facilities for this study*

I express my gratitude to ***Dr .S. Jaikish*** *for his help and motivation during this study*

I sincerely thank ***Dr.K .Mohamad Ali, Dr .Vijayalaxmi*** *for helping me in the statistical analysis*

I express my gratitude to all patients and their family for their kind cooperation during the study.

My heart full thanks for their help, patience and whole hearted support in bringing out this study.

I dedicate this work to my parents

And Teachers

INTRODUCTION

INTRODUCTION

Cervical spinal injuries when associated with neurological deficit is a devastating problem leading on to significant morbidity and mortality . 6% of trauma patients have spinal injury in which more than 50 % is contributed by cervical spinal injury.

Every year around 90 to 100 cases of cervical spine injuries are getting admitted in the Orthopaedic department of Thanjavur Medical College Hospital , Thanjavur.

Our study is to analyse the functional outcome and recovery of cervical spine injuries treated by **anterior cervical decompression and fusion with stabilization using locking titanium anterior cervical plate .**

AIM

To analyse the functional outcome of anterior cervical decompression and fusion with stabilisation using locking titanium anterior cervical plating for sub axial cervical spinal injuries .

HISTORICAL REVIEW

Reviewing the early history of cervical spinal injuries,we came to know that it is **“an ailment not to be treated** “ as mentioned by the Egyptians in the Edwin Smith Papyrus . The traction was used during Hippocrates period . In 1877, Boutecou was among the first to reduce fractures with weight attached by adhesive tapes to the patient face. Taylor introduced head halter traction in 1929, which was improved by Crutchfield in 1933 with the introduction of his head holding tongs. To Nicel et al, goes the distinction of the concept and refinement of the use of halo immobilization .

The first individual to propose a more aggressive treatment of cervical spine trauma was Hildanus (1672) Who described a technique for reducing fracture dislocation of the cervical spine .

As early as the seventeenth century , Paul of Agena , suggested surgical excision of fractured spinous processes for treating spinal disorders .

A French surgeon, Chipault in 1894 published perhaps the first textbook on spinal surgery presenting the most complete survey of past and current spinal surgery. In 1856,he brought out specialist yearbook “travaux de neurology chirugicale” which became the first neurosurgical journal in the world . In 1904 , He published manual “de orthopaedic vertebraele” , which primarily dealt with the orthopaedic treatment of spinal disorders .

Bailey and Badgley described a procedure in 1960 to treat instability by fusion with iliac crest graft. Their initial series consisted of 20 patients with instability due to trauma, tumour ,infection . Their technique involved creating an anterior trough in the vertebrae . The canal was not routinely opened . It should be noted that this series did not include degenerative disc disease .

Verbeist et al in 1966 espoused using autogenous cortical bone. Simmon and Bhallia in 1969 described a “ keystone “ Graft of the iliac crest . Whitcloud and La Rocca in 1976 advised the use of cortical fibula .

Anterior cervical fusion was first performed by Bailey and Badgley[1] in the early 1950s. Cloward[8,9], Smith, Robinson[31],and others advanced the techniques of cervical fusion. But pseudarthrosis rates for multilevel procedures were as high as 40%, even when external orthotic devices were used. The first anterior cervical plate and screw system was developed by Bohler[3] in 1964. But the widely available anterior plating system were the ones which were developed by Caspar[5] and Orozco[23] in the early 1980" s .The next major development in ACP constructs was the Synthes CSLP, developed in Europe by Morscher[22] in the 1980s and introduced into the United States by Synthes in the early 1990s, The Orion plating system was developed after the Synthes and offered variable-length screws, from 10 to 26 mm, allowing the surgeon to choose between uni and bicortical screw purchase.The Codman plate system was developed to allow for variability in screw direction and to prevent screw backout. Acromed's development of the DOC anterior cervical stabilization system marked the first so-called "translational" cervical stabilization system.

EVOLUTION OF ANTERIOR CERVICAL PLATES

The first anterior cervical fusion was performed by Bailey and Badgley in the early 1950s. Cloward,[8,9] Smith and Robinson,[31] and others offered early contributions to the improvement of techniques of cervical fusion. These pioneers encountered high rates of pseudarthrosis and kyphosis in multilevel anterior procedures. This led to the development of an anterior internal cervical fixation device by Bohler[3] in 1964, which was the foundation of the numerous plates available today.

During the last 20 years Anterior Cervical Plates have evolved. There have been improvements in fusion rates in patients undergoing multilevel anterior cervical fusion as well as in patients undergoing single-level fusion. Anterior cervical fusion has been shown to contribute to earlier patient mobilization, a decreased need for cervical collars postoperatively, an increased loading force applied to the graft, a decreased incidence of graft dislodgment, and an improved ability to fix spinal deformities.

Fig. 2. Anterior view of the Caspar plate, which is an stricted backout plate.

EVOLUTION OF ACP SYSTEMS

A variety of plate designs currently exist to stabilize the cervical spine and promote fusion. The available options for cervical plating are listed below.

- Non-constrained – Bicortical non-locked bone screw
- Semi-constrained – Locked bone screw with possible construct motion
- Constrained – Locked bone screw with no construct motion
- Rotational Load Sharing – Screw rotates about a pivot point
- Translational Load Sharing – Screw translates along a slot in the plate.

EARLY ANTERIOR CERVICAL PLATES

Unrestricted Backout Plates In 1970 Orozco and Llovet[23] were the first to report their use of a plate produced by the ASIF.[20] These authors used H-shaped ASIF plates, which were the predecessors of the current plate made by Synthes Spine. In the early 1980s, Caspar popularized anterior cervical plating in collaboration with Aesculap, Inc. . Orozco and Caspar plates were both unrestricted backout plates. In this construct, the screw angulation was determined by the patients' needs and the surgeon's preference. These constructs did not have a fixed-moment arm and, furthermore, had limited fixation at the screw–plate interface. This led to greater exposure of the graft to compressive forces, allowing for a higher chance of fusion.

The unrestricted backout plates had several disadvantages suchas the demand for a bicortical screw purchase, which was technically demanding. Overpenetration could result in spinal cord injury, and underpenetration could result in construct failure and screw pullout. Furthermore, the cumbersome and difficult task of fluoroscopy was

necessary to visualize the lower cervical regions. The Orozco and Caspar plates were nonrigid;that is, motion was allowed at the plate–screw interface.

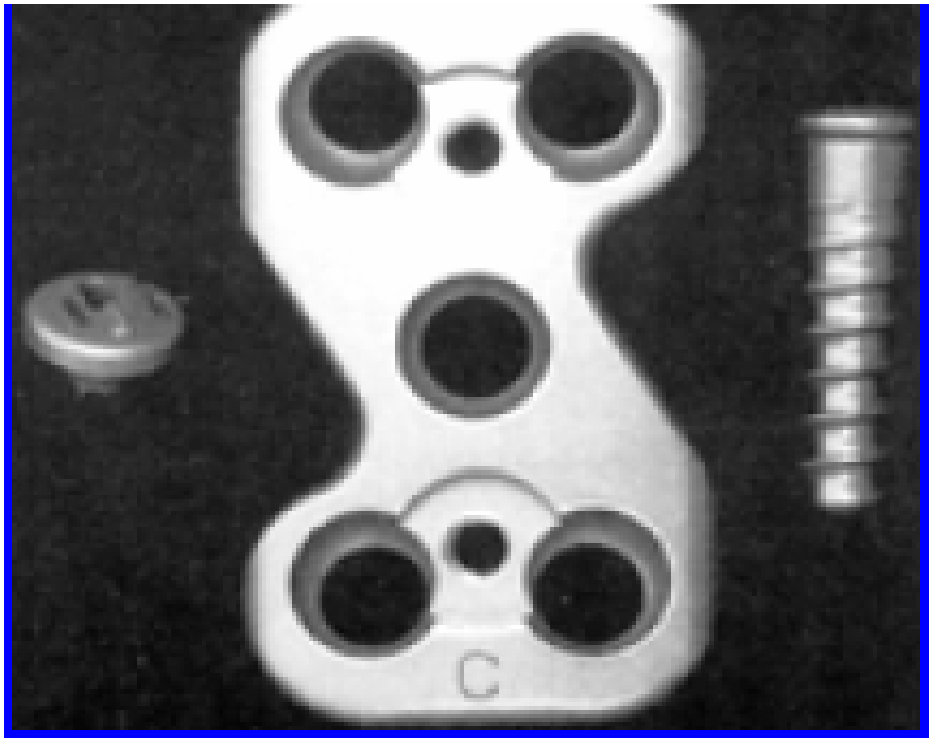


Fig. 4. Anterior view of the Orion plate and screw; this . a constrained, restricted backout plate.

NEWER GENERATIONS OF ACPS

RESTRICTED BACKOUT PLATES

CONSTRAINED SYSTEMS

At the same time the Caspar plate was being developed, Raveh produced a titaniumcoated hollow-screw reconstruction plate at the University of Berne.[18] By inserting an expansion bolt into the lathe, the screw was rigidly affixed to the plate, avoiding the need for a bicortical purchase. In Switzerland, Morscher modified the Orozco plate for use with unicortical, locking screws; this was reported in 1986.[22] The system was introduced in US in 1991 by Synthes . The Synthes CSLP did not require a bicortical purchase because a titanium expansion screw was used to affix the screw rigidly to the plate. [10,19,20] The advantage of the unicortical screw purchase was that intraoperative fluoroscopy was not necessary and, thus, operative time was reduced. In addition, the locking screw helped prevent screw backout. Another difference between the Caspar plate and the Synthes plate was that there was a fixed angle of entry for the screw and plate in the latter. The Synthes screw lengths were available in a limited range. Because the average diameter of an adult vertebral body ranges between 21 and 22 mm, the risk of overpenetration past the posterior aspect of the vertebral body was rare. In the Synthes

system the rostral screw was oriented 12° cephalad, whereas the caudal screw was placed perpendicularly. One disadvantage of the original Synthes plate was that it was wide and diffi-. cult to contour. To resolve this problem in new Synthes plate the curvature radius was reduced from 25 to 15 mm. The Orion plating system, which was developed after the Synthes plate, offered a variable screw length.

This allowed a unicortical or bicortical purchase to be achieved. One feature of the Orion plate was the prebent lordosis, which provided a better bone–plate interface. With the Orion plate, a drill guide that locked to the plate was used to ensure that the screws had a fixed angle. The angle of the screws used with this system was 15° cephlad and caudal and 6° medial. In theory this construct prevented screw pullout. In the Orion system a tapered screw, which had a core diameter of 2.4 mm and a thread diameter of 4 mm, was used. The advantage of the tapered screw lay in the distribution of stress throughout the length of the screw.

This decreased the risk of screw breakage. The Orion system had some disadvantages, however. For instance, some investigators found a high incidence of pseudarthrosis (12%) in patients who underwent one-level anterior cervical discectomy and fusion. [13] Furthermore, many surgeons believe that this plating system was too rigid and that, therefore,

the plate absorbed the stress on the construct. [11] This lack of stress may inhibit fusion.

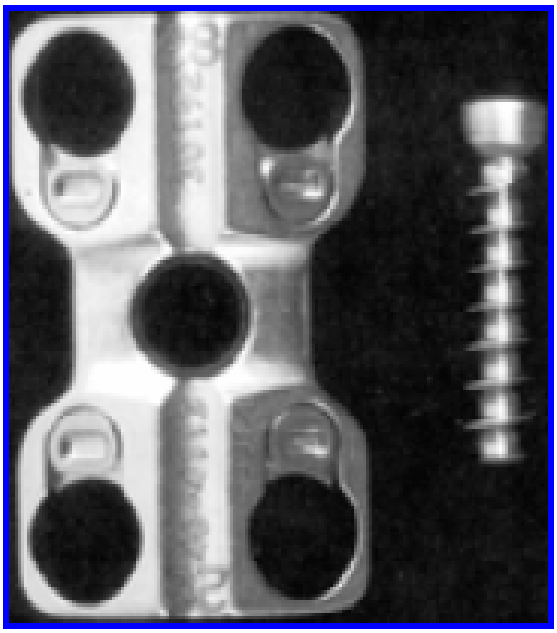


Fig. 5. Anterior view of the Codman plate and screw; this ACP is a semiconstrained, rotational system with a restricted backout feature.

SEMICONSTRAINED, ROTATIONAL SYSTEMS

The next generation of anterior cervical plating systems was the dynamic plates, which are also referred to as semiconstrained plates.

This means that there were locked bone screws that allow motion of the construct. Dynamic plates have been divided into rotational plates, which allow rotation at the plate–screw interface, and translational plates,

which allow axial translation and rotation. Examples of rotational semiconstrained plates are the Codman, Blackstone, Peak, Aline, Acufix, Deltaloc (Alphatec Manufacturing, Inc.), Zephir, and Atlantis (hybrid and variable) plates .The Codman plate contained a cam lock to restrict backout . This system was different from previous plates in that it allowed for variability in screw direction. The screws for this system were tapered to spread the stress along the length of the screw. This reduced the likelihood of screw breakage. The rotational screw–plate interface in the Codman system was designed in a way to increase the load on the graft, therefore increasing the rate of graft fusion. Although good results have been achieved using the Codman plate for short and intermediate segment fixation, treatment failure has occurred in patients with multilevel corpectomies or unstable spines without posterior fixation. [11] Codman's newest ACP is SLIM-LOC. The company claims that this is the smallest ACP available on the market. The profile of the plate is 2.1 mm.

RESTRICTED BACKOUT PLATES

Semiconstrained, Translational Devices. Translational plates were designed to provide translation and rotation at the screw–plate interface. Movement at the screw–plate interface was planned to avoid stress shielding so that, theoretically, fusion rates would increase and time to

fusion would diminish. This concept follows the Wolff law, which suggests that loading alters bone integrity and bone healing[2] that is, bone heals more optimally when exposed to a compressive load. Examples of translational devices include ABC, DOC, and Premier plates. Dupuy Acromed developed the first translational system, which was referred to as the DOC rod. This plate was designed so that the cephalad screws would be able to slide along a rail, whereas the caudal screws would rigid

.

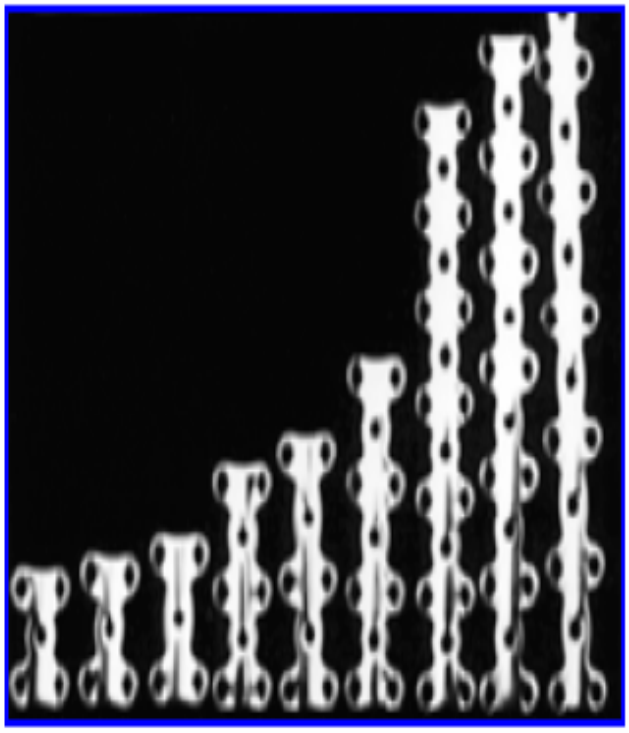


Fig. 1. Photograph showing H-shaped ASIF plates, which were one of the earliest ACPs used.

Fig. 3. Anterior view of the SCSLP, a restricted backout plate available in two sizes.

Using the DOC plate the extent of axial deformation could be controlled by a cross-fixator that allows the implant to control the amount of settling (controlled dynamism). The newer version of this plate, which is now referred to as the DOC plate, is a rigid implant in which a two-piece locking expansion screw system is used. This plate allows for the intraoperative visibility of the bone graft through its specially designed "graft site window." The preset screw trajectories are designed to create a 15° superior and inferior screw path along with a 5° medial trajectory. The ABC plating system designed by Aesculap is both a translational and rotational system. The Premier plate, manufactured by Medtronic Sofamor Danek, allows for a translational motion of the screw that is similar to that seen when using the DOC plate. Screws first translate in a slot and may then rotate after maximum translation.

MULTICONSTRUCT SYSTEMS

The Atlantis ACP system is one of the newest plate systems and can be used with either a variable-angle screw or a fixed-angle screw. In other words, a construct can be created that is rigid, rotational, or a "hybrid" (combining technologies). In the fixed Atlantis construct two fixed-angle screws that allow no rotation or translation are used. The screws are angled at 12° cephlad and caudal and 6° medially. The variable

Atlantis system is similar to the Codman plate system in that it includes two sets of variable angle screws and allows for rotational motion for both the superior andinferior sets of screws. The hybrid Atlantis system includes fixed-angle and variable-angle screws. The advantage of the hybrid system is that compressive forces can promoted bone graft and fusion. Haid and colleagues [11] have found this Atlantis construct to be useful in performing cervical corpectomies and discectomies. Furthermore, this group has found that the fusion rates and clinical outcome, achieved using the Atlantis system match or exceed the results obtained using other plates.

To sum up over the past 20 years, although the basic design of ACPs has stayed the same, several important features have been added to the newer generation of plates. Although all the current cervical plates provide appropriate fusion success, it is important to know which plate fits the patient's needs. Newer types of plates, such as semiconstrained rotational and translational systems and multiconstruct systems, still need to be studied in detail. The development of newer ACPs will depend on what we have learned from the shortcomings of the plates available today.

ANATOMY

DEVELOPMENTAL ANATOMY OF CERVICAL SPINE

During the third week of intrauterine life, the development of mesoderm on either sides of the neural tube and the notochord becomes aggregated into a series of mesodermal blocks called somites . Shortly after its formation ,each somite differentiates into a ventromedial part , the sclerotome and a dorsolateral part , the dermatomyotome .During fourth week , the former forms the vertebrae , ribs and spinal ligaments while the latter forms the Musculature and the dermis of scalp ,neck , trunk.

The cranial half of the first cervical sclerotome fuses with the caudal portion of the fourth occipital somite to help form the basilar portion of the occipital bone . Then the caudal half of the first cervical scerotome to form the first cervical vertebra . The same type of fusion is repeated down the length of cervical spine .Ventrally sclerotomal cells forms the vertebral

bodies,discs. Dorsally they form the pedicles and lamina of the vertebrae.The apical and alar ligament of the atlantoaxial articulation as well as the nucleus pulposus of the intervertebral discs form from the notochord .Spinal growth occurs by enchondral ossification that is preceded by mesenchymal chondrification during weeks five and six.

CLINICAL ANATOMY

The vertebral column is made up of five parts viz ., cervical , thoracic , lumbar ,sacral and coccygeal parts . The cervical spine consists of seven cervical vertebre , first two of which atlas and axis are atypical .

TYPICAL VERTEBRA

Typical vertebrae extending from C-3 to C-7 are structured to provide limited flexion, extension ,tilt and rotation as well as to provide stability to support the head .The typical lower cervical vertebra is made up of body, paired pedicle, paired transverse process, paired lamina, paired lateral mass ,superior and inferior articular process and a spinous process. The vertebral bodies have a superior surface, which is convex anterosuperiorly and concave laterally. This configuration allows flexion, extension and lateral tilt by gliding movements of the facets. The inferior

surface of the vertebral body is convex. The lateral aspect of the vertebral body has superior projection called Uncinate process which articulates with inferior aspect of the cephalad vertebra to form Uncovertebral joint (or) Joint of Luschka. The lateral processes contain the foramen transversorium through which the vertebral artery courses.

The pedicle connects the body to the lamina and lateral masses. The nerve roots exit the central canal through the intervertebral foramen and course along the lateral processes between the lateral mass and the body.

The lamina are thin and give rise to bifid spinous process that serves as site for muscular attachment. The lamina and spinous process of C-2 are the largest, whereas C-3,4,5 have thin laminae to help assume the normal lordotic posture. The laminae of 6^{th} and 7^{th} cervical vertebrae become progressively thicker and larger to approach the size of the thoracic vertebrae. The facet joints are placed in a coronal plane, angled 45 to the horizontal. Due to this 45 inclination, lateral tilt is accompanied by rotation and vice versa. The gliding motion of the facets allo flexion, extension and lateral tilt.

The vertebral bodies are bound anteriorly by the anterior ligament complex, consisting of anterior longitudinal ligament, the anterior portion of intervertebral disc and annulus and posterior longitudinal ligament and posterior portion of IV disc and annulus fibrosus. The posterior ligamentous complex is made up of facet capsules, the interspinous ligaments (or) the ligamentum nuchae , and the supraspinous ligament.

NEURO ANATOMY

The spinal cord is elongated, approximately cylindrical part of the central nervous system , occupying the superior two –thirds of the vertebral canal . Its average length in males is 45cm , its weight is about 30 gm . It extends between the levels of the upper border of atlas and the junction between the first and second lumbar vertebrae. The spinal cord is enclosed in the dura , arachanoid , piameters and seprated by the subdural and subarachanoid spaces , the former being merely potential , the latter containing cerebrospinal fluid . It continues cranially with medulla oblongata and narrows caudally to the conus medullaris the apex of conus medullaris descends the filum terminale , a connective tissue filament which gets attached to the dorsum of first coccygeal segment . The

transverse width of the spinal cord varies , with tapering towards its caudal end .

Arising from the cord is a series of paired dorsal and ventral roots of spinal nerves. These cross the subarachanoid space and traverse the duramater separately, uniting close to their intervertebral foramina to form the spinal nerves. The region of spinal cord associated with the emergence of a pair of nerves is a spinal segment, but there is no actual surface indication of segmentation .

VERTEBRAL LEVELS OF SPINAL CORD SEGMENTS

The level of spinal segments relative to the vertebrae is clinically important. A useful approximation is ; at cervical spine the cord level is one segment higher than the vertebral level , in upper dorsal it is two segments ; in the lower dorsal region there is a difference of three segments . The twelfth thoracic spine is opposite the first sacral segment .

VASCULARITY OF THE SPINAL CORD

Blood reaches the spinal cord along spinal branches of the vertebral artery, deep cervical , intercostals , and lumbar arteries ; with the anterior and posterior spinal arteries form longitudinal anastomotic channels along the cord . Spinal arteries send anterior and posterior radicular branches to the spinal cord ventral and dorsal roots . central branches of the anterior

spinal artery supply the anterior 2/3 of the spinal cord . The rest of cord is supplied by the posterior spinal artery.

Spinal veins drain into six tortuous , often plexiform longitudinal channels, one each in the anterior and posterior median fissures and four others, often incomplete, one pair being posterior, the others anterior to the ventral and dorsal nerve roots. These vessels connect freely with the cerebellar veins and cranial sinuses.

BIOMECHANICS OF CERVICAL SPINE

Movements occurring at lower cervical spine are flexion , extension , lateral bending and rotation . Flexion and extension are free and it is greater at C-5,6 and C-6,7 . Neck movements diminish with age . The local vertebral alignment at the level of injury and the magnitude of impact force determine the pattern of injury . Head deflection occurs secondarily.

Cervical fractures can also occur without head contact , and hence the same injury mechanism may result in a morphologically different injury and hence the patterns of head deflection do not predict the injury pattern.

A motion segment is made up of two adjacent vertebra and intervening soft tissue. If a motion segment has the anterior and one posterior elements (or) all the posterior and one anterior element intact , then it will remain stable under physiological load.

CLASSIFICATION OF CERVICAL SPINAL INJURIES

Allen and Fergusson developed the most commonly used classification. Injuries are divided into six phylogenies which are then further subdivided into stages.

(a) COMPRESSION FLEXION

Due to axial loading with flexion of increasing severity

Stage 1 - Blunting of superior vertebral body

Stage 2 - Beaking of superior vertebral body

Stage 3 - Beak fracture or Tear drop fracture

Stage 4 - Retro listhesis of vertebral body < 3mm

Stage 5 - Retro listhesis of vertebral body > 3mm

(b) VERTICAL COMPRESSION

Due to axial loading in relative isolation

(No flexion / extension of head)

Stage 1 – Cupping of superior or inferior end plate

Stage 2 - Cupping with minimally displaced fracture

Stage 3 - fragmentation and retropulsion of bony fragments into the canal

(b) **DISTRACTIVE FLEXION**

Due to posteriorly applied distraction forces with spine in flexion

Stage 1 – Less than 25% subluxuation of facets with superior and plate blurring

Stage 2 - Unifacetal dislocation

Stage 3 – Bifacetal dislocation

Stage 4 – Bifacetal dislocation with displacement of full vertebral width

(d) COMPRESSIVE EXTENSION

Due to axial loading with neck in extension

Stage 1 – Unilateral laminar fracture

Stage 2 – Bilateral laminar fracture

Stage 3 – Nondisplaced bilateral arch fracture

Stage 4 – Partially displaced bilateral arch fracture

Stage 5 – Fully displaced bilateral arch fracture

(e) DISTRACTIVE EXTENSION

Due to anteriorly applied distraction forces with spine in extension.

Stage 1 – Anterior longitudinal ligament distruption with transverse body fracture

Stage 2 – significant displacement and posterior column injury

(f) LATERAL FLEXION

Due to blunt trauma from side places the ipsilateral spine in distraction and contralateral spine in compression.

Stage 1 – Assymmetrical vertebral body fracture with a unilateral arch fracture.

Stage 2 – Displacement of body and contralateral ligament injuries.

ORTHOPAEDIC TRAUMA ASSOCIATION CLASSIFICATION

OF LOWER CERVICAL SPINE

A1-1	:	Spinous process fracture
A1-2	:	Extension avulsion or Tear drop
A1-3	:	Lateral mass fracture without subluxuation
A1-4	:	Isolated Lamina frature
A1-5	:	Ligament strain
B1-1	:	Facet injury
B1-1-1	:	Fracture dislocation unilateral
B1-1-2	:	Fracture dislocation bilateral
B2-2-1	:	Facet dislocation
B2-2-1	:	Without fracture –unilateral
B2-2-2	:	Without fracture – bilateral
B3-3-1	:	With displacement – unilateral
B3-3-2	:	With displacement - bilateral
C	:	Severe injuries
C1-1	:	Flexion tear drop
C1-2	:	Severe ligament injuries
C3-1	:	Compression fracture
C3-2	:	Burst fracture

MANAGEMENT

Goals of the treatment in cervical spinal injuries are

1. To protect against further injury
2. Optimise conditions for maximal neurological recovery.
3. Maintain or restore spinal alignment
4. Minimise loss of spinal mobility
5. Obtain a healed and stable spinal column
6. Facilitate rehabilitation

FIELD LEVEL

Proper extrication of the patients and immobilisation of the cervical spine are critical to avoid neurological injury . Immobilisation with cervical collar , sand bags and spinal board is ideal . Cervical extension narrows the spinal canal hence neutral position is safe.

EMERGENCY DEPARTMENT

All patients are treated in intensive care unit with strict monitoring of vitals. Patient with cervical spine injury with neurological deficit were given high dose of steroid as per NASICS III study. The standard dosage is 30 mg/kg loading dose given over 15 minutes, followed by continuous administration I of 5.4 mg/kg/hr. Patients strated on steroid theraphy < 3 hrs of injury need only continious theraphy for 24 hrs where as those

came between 3 & 8 hrs after injury should maintain theraphy for a total of 48 hrs.

Experimental and clinical studies are on progress for other pharmacological agents like lazaroids ,trilazad mesylate ,NMDA channel blockers, glutamate.

Treatment of neurogenic shock is mainly by pharmacological intervention. The Mean arterial pressure is to be maintained at 85 to 90 mmHg, which can be done with crystalloid ,colloid, whole blood transfusion and vasopressors . Maintanance of Mean Arterial Pressure to 85 to 90 mm of Hg is essential to prevent the secondary injuries there by decreasing the morbidity and mortality assoiated with SCI.

Patients may need ventilator support when there is respiratory insufficiency. The patients must be rolled on his /her side using a logrolling maneuver for complete examination of cervical spine.

Neurological examination is performed concurrent with resuscitation and haemodynamic stabilisation .The ASIA has recommended essential elements of neurological assessment in all patients with spinal injury. This includes motor power of ten muscles on each side of body and pinprick assessment at specific sensory location .The sum of motor and sensory score is calculated and compared with normal.

ASIA IMPAIRMENT SCALE AND ASIA SCORE

The ASIA impairment scale is nothing but a modification of Frankel s grading which is easy to evaluate, interpret and follow up. It also has a minimal inter observer variation and better reproducibility.

A. Complete No motor or sensory function in the lowest sacral segment
B. Incomplete Sensory function preserved below the neurological level but no motor function.
C. Incomplete Motor function preserved below the neurological level and more than half of the key muscle groups have grade < 3.
D. Incomplete Motor function preserved below the neurological level and more than half of the key muscle groups have grade > 3
E. Normal Sensory and motor function normal Strength assessment of 10 muscles on each side of body, and pinprick discrimination and light touch assessment at 28 sensory locations are done and scores are given. The maximum motor score of 100 and sensory score of 224 is normal.

SPINAL SHOCK

Immediate depolarisation of axonal membranes from kinetic energy causes spinal shock , in which there is disruption of all cord function distal to injury ,including reflexes .It usually resolves within 24 hrs of injury but rarely it can take many weeks. Hence examination conducted between 72

hrs and 1 week after injury more accurately predict muscle recovery than examination conducted within 24 hrs . Return of bulbocavernous and anal wink reflex indicates the end of spinal shock.

TYPE OF LESION

They further classified into complete and incomplete lesions.

COMPLETE

When there is no motor on sensory function below the level of injury at the end of spinal shock. The prognosis for recovery is poor.

INCOMPLETE

When there is some motor (or) sensory function is spared distal to cord injury. It can be either a central, anterior, posterior or a Brown Sequard syndrome.

CENTRAL CORD SYNDROME

This is the most common spine injury and it is due to destruction of central area of spinal cord including both grey and white matter. The centrally located arm tracts in the corticospinal tracts are the most severly affected. Sensory sparing is variable. Prognosis for recovery is variable and more than 50 % recover bladder and bowel and become ambulatory. Functional use of hands rarely recovers.

It usually results from hyperextension injury in an older person with pre existing osteoarthritis of spine.

BROWN SEQUARD SYNDROME

The most prognostically favourable incomplete spinal cord injury with more than 90 % of patients recover bowel or bladder and ambulatory function. It presents with ipsilateral loss of motor function and proprioception and contralateral loss of light touch and pinprick.

It is usually the result of unilateral lamina or pedicle fracture or rotational injury due to subluxation.

(C) ANTERIOR CORD SYNDROME

It is due to damage to the anterior 2/3 of spinal cord and characterised by complete motor and sensory (pain and temperature) loss distal to the level of injury .The posterior column is spared.

It is due to hyperflexion injury in which a bone or disc compresses the anterior spinal artery and cord. Prognosis for recovery in this injury is poor.

(D) POSTERIOR CORD SYNDROME

It involves the dorsal columns of the spinal cord and produces loss of proprioception, vibration sense while preserving other motor and

sensory function. This syndrome is rare and usually by an extension injury.

A mixed syndrome is usually an unclassifiable combination of several syndromes.

RADIOLOGICAL EXAMINATION

Spinal clearance in poly trauma patients is a combination of clinical assessment and radiological evaluation as necessary. Systematic evaluation is necessary to avoid missed injuries.

SEQUENCE

Plain radiographic study remains the primary diagnostic spine evaluation. Complete cervical spine views should be obtained once the patient is medically stable. These views are open mouth, antero-posterior, lateral, right and left oblique views. Alternatively patients can be screened for a cervical spine injuries with a rapid sequence Helical CT scan . Patients with an incomplete spinal cord injury may require an emergent MRI scan.

RADIOGRAPHS

Cervical radiograph should be performed in supine position. The patient is not moved to position for the various views, but the X- ray beam and film position is adjusted to provide the desired image sequence.

Accurate interpretation of the lateral cervical spine radiograph is essential. An adequate lateral X-ray must visualise occiput to the first thoracic vertebra. Traction to both the upper limbs should be given so that the shoulders do not obstruct the lower cervical spine. If the lower cervical spine is not seen a Swimmers view may taken.

Alignment of the cervical vertebra is assessed by drawing longitudinal lines along the vertebral bodies, lamina, spinous process. The prevertebral soft tissue measurement is an indirect evidence of cervical spine injury and it is significant when it is more than 5 mm at C-3 level

Open mouth view is essential for excluding C-1 arch fracture and odontoid fracture.

COMPUTED TOMOGRAPHY

In general CT scan are indicated for patients with suspected spinal fractures and dislocation that are not identified on plain radiographs, patients with incomplete visualization of the spinal column and following myelography. Excellent bony detail of the fracture pattern usually can be obtained with CTscan.

MAGNETIC RESONANCE IMAGING

The indications for MRI scan are any incomplete spinal cord injury and to assess the status of disc and ligament injuries. It is 90 % sensitive

and 100 % specific. Increased cord signals are associated with poor prognosis.

SCIWORA - Spinal Cord Injury Without Roentgenographic Abnormalities

Spinal cord injury without roentgenographic abnormalities has been reported by Dickment et al to occur predominantly in children. Because of the inherent elasticity of the juvenile spine, the spinal cord is vulnerable to injury even though the vertebral column is not disrupted. The recovery depends on the patient s neurological status at presentation. Those with incomplete injuries tend to recover well.

DEFINITE MANAGEMENT

CLOSE REDUCTION

Attaining close reduction and skeletal alignment may theoretically decompress the compromised neurological elements. The theoretical benefits of early neural decompression is to prevent the secondary injury. But no definite data exist on the timing of reduction. A.S .Lee has suggested that early reduction gives best chance of neurological recovery and rapid traction with serial addition of weights is more often successful and safer than manipulation under anesthesia.

Skull tongs are applied one finger breath above th helix of the ear in line with the tragus or external auditory meatus. If a flexion vector is necessary, the pin placement should be approximately 1 cm posterior to the neutral starting point. The starting weight is 5 pounds, then serial weight of 10 pounds each may then be applied, Concurrently with serial neurological examination should be done to monitor any changes in neurologic examination.

TECHNIQUE OF MANIPULATIVE REDUCTION

If the facets are locked on one side the manipulation technique is manual straight traction followed by side flexion away from the locked facet followed by rotation after achieving reduction it is maintained in hyperextension . For bilateral dislocation ,traction in flexion is applied to unlock the joint and then hyperextended to maintain reduction.

Failure of close reduction due to

- Traumatic Disc herniation
- Facet fractures ,Paracervical muscle spasm

NONOPERATIVE TREATMENT

It is indicated for stable cervical spine injury with no compression of neural elements . This includes Stable compression fractures of vertebral

bodies. Undisplaced fractures of lamina , lateral mass , spinous process ,Unilateral facet dislocation that are reduced in traction. Immobilisation is done either by rigid cervical collar or halovest for 8 to 12 weeks . Serial X – Rays are obtained weekly for the first 3 weeks and then at 6 weeks, at 3 months ,at 6 months , at one year to look for any instability.

Bucholz and Cheung found that patients who were treated non operatively had a failure rate of 15 % and they have a loss of reduction in 37 % of facet dislocation . Bucci et al had a 40 % failure rate in non operative treatment.The torn posterior ligaments do not heal well and are grossly lax.

SURGICAL TREATMENT

TIMING OF SURGERY

Some studies of early surgical intervention (within 3 to 5 days) have shown increased morbidity and mortality in patient with acute spinal injury . However ,others have demonstrated that early decompression and stabilization of cervical spinal injuries allow early patient mobilization and rehabilitation , as well as decreasing overall morbidity ,hospital stay ,and cost of treatment. Vaccaro and colleagues [46] noted no significant neurological benefit in patient who underwent surgery within 72 hours of injury. Results in animal studies seem to favour decompression within 8

to 12 hours. The evidence available to date is not sufficient to unequivocally support either early or delayed surgery.

Operative treatment of cervical spine injury is directed at

- ❖ Reducing the Deformity
- ❖ Decompressing the neural elements
- ❖ Maintaining the Alignment
- ❖ Stabilising the spine while bone fusion occurs

ANTERIOR APPROACH

An anterior cervical decompression is often performed in patient with symptomatic anterior neural compression.

Anterior interbody grafts alone are prone to displacement and deformity, if there is associated posterior instability.

Anterior decompression even after 1 year has resulted in neurological recovery.

Anterior and Posterior plating are equally effective in cervical trauma.

ARENA et al [39] and other authors has suggested the importance of herniated intervertebral disc in patients with subluxation or dislocation.

Imaging studies particularly MRI scan has shown that 20 to 60 % of dislocation are associated with disc prolapse, and the literature confirms that iatrogenic neurological injuries have occurred in patients in whom reduction and posterior stabilization were carried before anterior decompression. Hence anterior discectomy, interbody fusion with internal fixation would be the optimal treatment in such instances.

Anterior plating provides immediate and rigid stabilization even with posterior ligament injury.

POSTERIOR APPROACH

In general it is indicated most often in posterior ligament injury as healing is unlikely with external immobilization and hence posterior cervical fusion with interspinous wiring or oblique facet wiring may be indicated to obtain stability, maintain alignment and to prevent chronic pain or progressive deformity.

Posterior cervical plating by lateral mass fixation provides rigid fixation and is advantageous when lamina and spinous process are deficient.

COMBINED APPROACH

The complex pathology that is present with spinal trauma necessitates exposure of both anterior and posterior portions of spine. It can be done in staged procedure or sequentially in one procedure.

FACET DISLOCATION

In a unifacetal dislocation, if it can be reduced in skull traction halovest immobilisation can be used for 3 months with the possibility that spontaneous fusion will occur. If there is no spontaneous fusion or if it cannot be reduced by traction then open reduction and posterior cervical fuision can be done.

Bilateral facet dislocation are often easy to reduce by traction but they are very unstable and may require surgical stabilization most often open reduction and internal fixation with an interspinous or oblique wiring.

Anterior reduction, Decompression, Stabilisation, eliminates the risk of extrude disc fragments encroaching the spinal canal, and provides an effective method of reduction. It is also a easy method of stabilizing a single motion segment.

Anterior Discectomy, fusion and Rigid anterior stabilization can also be done with posterior ligament injury. Anterior internal fixation provides stability often making an additional posterior surgery unnecessary.

ARENA et al has recommended Anterior discectomy for removal of extruded disc material before posterior stabilization done.

FRACTURE INVOLVING VERTEBRAL BODY

For fracture of vertebral body producing compression of neural elements, with intact posterior column, surgery by anterior corpectomy fusion and anterior plating alone is indicated. For those fractures with posterior instability also, then a combined procedure (anterior decompression, fusion, posterior interspinous wiring) may often be required.

SURGICAL TECHNIQUE

ANTERIOR DECOMPRESSION AND FUSION

The lower cervical spine can be approached by Robinson and southwick technique. The patient is placed with supine with skeletal traction maintained through tongs. Either a horizontal or longitudinal incision can be used. An incision of 3 to 5 fingers breath above the clavicle for C-3 to C-5 and 2 to 3 finger breath above the clavicle for C-5 to C- 7 is made. The platysma is incised in line with skin

incision. The anterior border of sternomastoid identified and the plane between sternomastoid, carotid sheath laterally and strap muscles medially is made and the prevertebral area exposed. After identifying the level, the disc material and the retropulsed fragments are removed. Tricortical graft taken from iliac crest is used as a strut graft and anterior plating is done for stable fixation.

The current generation of anterior cervical instrument primarily uses unicortical screw fixation. Biomechanically, there appears to be little difference in terms of stability between unicortical and bicortical screw fixation.

SPINAL CORD INSTABILITY: (WHITE AND PUNJABI)

White and Punjabi has defined clinical instability as the loss of the ability of the spine under physiological loads maintain relationship between vertebra in such a way, that the spinal cord (or) nerve roots are damaged, and deformity (or) pain does not develop.

They have developed a checklist where in a score of 5 (or) more indicates instability.

ELEMENT		POINT VALUE
Anterior elements destroyed/unable to function	-	2
Posterior elements destroyed/unable to function	-	2
Saggital plane translation > 3.5 mm	-	2
Saggital plane rotation > 11 degree	-	2
Positive stretch test	-	2
Cord damage	-	2
Root damage	-	1
Congenital spinal stenosis	-	1
Abnormal disc protrusion	-	1
Dangerous load anticipated	-	1

MATERIALS & MEHTODS

All patients with Cervical spine injuries having neurological deficit who were admitted in orthopaedic department , Thanjavur Medical Coellge Hospital ,Thanjavur were included in this study conducted between August 2005 – July 2007 , which was prospective one .

INCLUSION CRITERIA

All subaxial cervical fracture and fracture dislocation.

EXCLUSION CRITERIA

1. SCIWORA -Spinal cord injury without radiological abnormality
2. Multiple spine injury

We had Sixteen patients in our study and One patient was lost for follow up . Hence the results of 15 patients are presented here in this study. There were twelve male and three female included in our study. Out of fifteen cases four were complete and remaing eleven cases were incomplete spinal cord injuries.

All cases were preoperatively assessed clinically by ASIA grading and radiologically by X –Ray AP,lateral, open mouth,oblique, swimmers lateral views and CT ,MRI. Appropriate informed written

consent was obtained from the patient and their relatives after explaing the purpose of the surgery and the neurological recovery. Out of fifteen patients , two got admitted within eight hours of injury and only these two patients received the methylprednisolone therapy.

All patients were treated in intensive care unit with strict monitoring of vitals like pulse rate ,blood pressure , oxygen saturation, respiration. If the mean arterial blood pressure is below 90 mm Hg intravenous fluid in the form of crystalloid or colloid, or blood, or plasma is given .If oxygen saturation is less than 90 % the supplemental oxygen at rate of 3 liters/min is given via a face mask.

Injection methyl prednisolone in the dosage of 30 mg /kg as IV bolus and 5.4 mg / kg / 23 hours was given for patient who presented to us within 8 hours of injury

While resuscitation, patients are evaluated neurologically on the basis of ASIA impairment scale. Patient were classified into complete or incomplete lesion based on the preservation of motor or sensory function distal to the level of lesion.

RADIOLOGICAL INVESTIGATIONS

Once the patient was stabilized radiological evaluation was done by X -- ray of cervical spine --- anteroposterior and lateral view with traction to the shoulder.

CT scan was done to see the bony details especially in retropulsed fragments in unstable burst fractures.

MRI evaluation was done as early as possible to know the status of disc, ligament injury & more importantly to know the status of the spinal cord .

CLOSED REDUCTION

If there is unifacetal or bifacetal dislocation and there is no evidence of posttraumatic disc prolapse in MRI, then the reduction is attempted by rapid traction method in which serial weights are added to the skull traction under close monitoring of neurological status.

All patients with posttraumatic disc prolapse were immobilised with hard cervical collar followed by surgical decompression planned at the earliest possible.

SURGICAL TREATMENT

TIMING OF SURGERY

All patients were assessed for surgery at the earliest possible time which ranged from minimum of one day to maximum of thirty six days with average of 11.2 days.

TYPE OF SURGERY

ANTERIOR CERVICAL DECOMPRESSION, FUSION WITH STABILISATION USING LOCKING TITANIUM ANTERIOR CERVIACL PLATE

PROCEDURE

ANTERIOR APPROACH

Anesthesia: cuffed end tracheal tube

Position : supine with neck in slight extension , sand bag under the shoulder blades. axial traction of cervical spinne is maintained by skull tongs throughout the procedure .

TECHNIQUE

ROBINSON & SOUTHWICK

Either a transverse or vertical incision is used .the incision is centered 3-5 fingerbreaths above the clavicle for C 3 – C 5 and 2-3 finger breaths above the clavicle for C6 and C7 .

Skin and platysma are incised. The superficial layer of deep cervical fascia is incised. The anterior border of steromastoid muscle is identified ad retracted laterally. Then the middle layer of deep cervical fascia is incised. The carotid sheath and sternomastoid is retracted laterally. The oesophagus, trachea, thyroid gland is identified and retracted medially.

The deep layers of deep cervical fascia consisting of pretracheal and prevertebral overlying the longus colli muscle are bluntly divided.The level of injury is identified clinically ad fluoroscopically. Then the longus colli muscle is retracted subperiosteally up to the level of uncovertebral joints.

The anterior longitudinal ligament and annulus is incised and the disc material is removed with curettes. The disc material is removed till the posterior longitudinal ligament is visualized. Corpectomy if indicated can be done using power burrs till the posterior part of vertebral body is reached. Then the posterior cortical wall is removed using pituitary rongeurs. The retropulsed bone and disc fragments are removed completely.

After completion of discectomy or corpectomy, reduction is done using manual traction or by using vertebral body spreaders or by using Casper pins. Then the superior and inferior end plates are prepared.

Tricortical iliac graft is taken and fitted in the gap and traction is released. Bone graft and disc space distraction was checked with image intensifier. If adequate reduction and distraction is achieved anterior cervical locking plating applied with four locking screws and two head locking screws with imaging control. We were not applied the screws into the graft for the fear of graft breakage and collapse. Wound was closed in layers after perfect hemostasis.

We have used the locking anterior cervical –ORION plate

TYPE	FREQUENCY	PERCENT
ANTERIOR DISCETOMY, FUSION	**11**	**73.3**
ANTERIOR CORPECTOMY, FUSION	**4**	**26.7**

POSTOPERATIVE TREATMENT

All patients are immobilized with Philadelphia cervical collar.

2-nd day : patient are encouraged to sit in the bed with or without support depending on their neurological status.

10^{th} day : suture removal and depending on their improvement in neurological status patient are mobilized from bed .

6^{th} and 12^{th} week : radiological evaluation done for assessing the fusion by flexion and extension X- rays and if solid fusion is seen, the collar is removed and neck movements are progressively started .

FOLLOW UP

Subsequently the patient is followed at every month till 6 months and then every 2 months during the next 6 months and thereafter every 6 months.

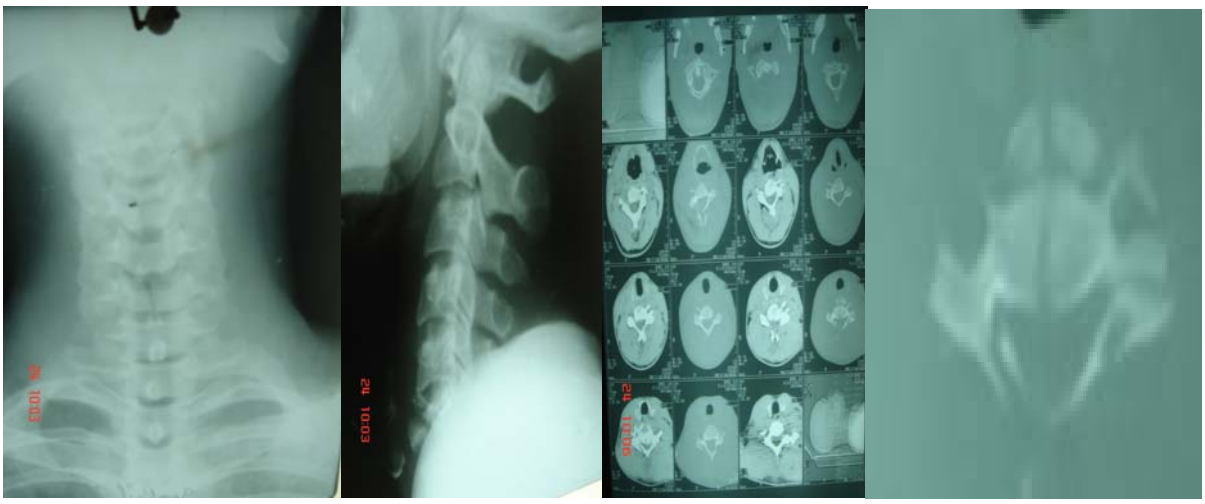
REHABLITATION

Chest physiotherapy - given from preoperative period

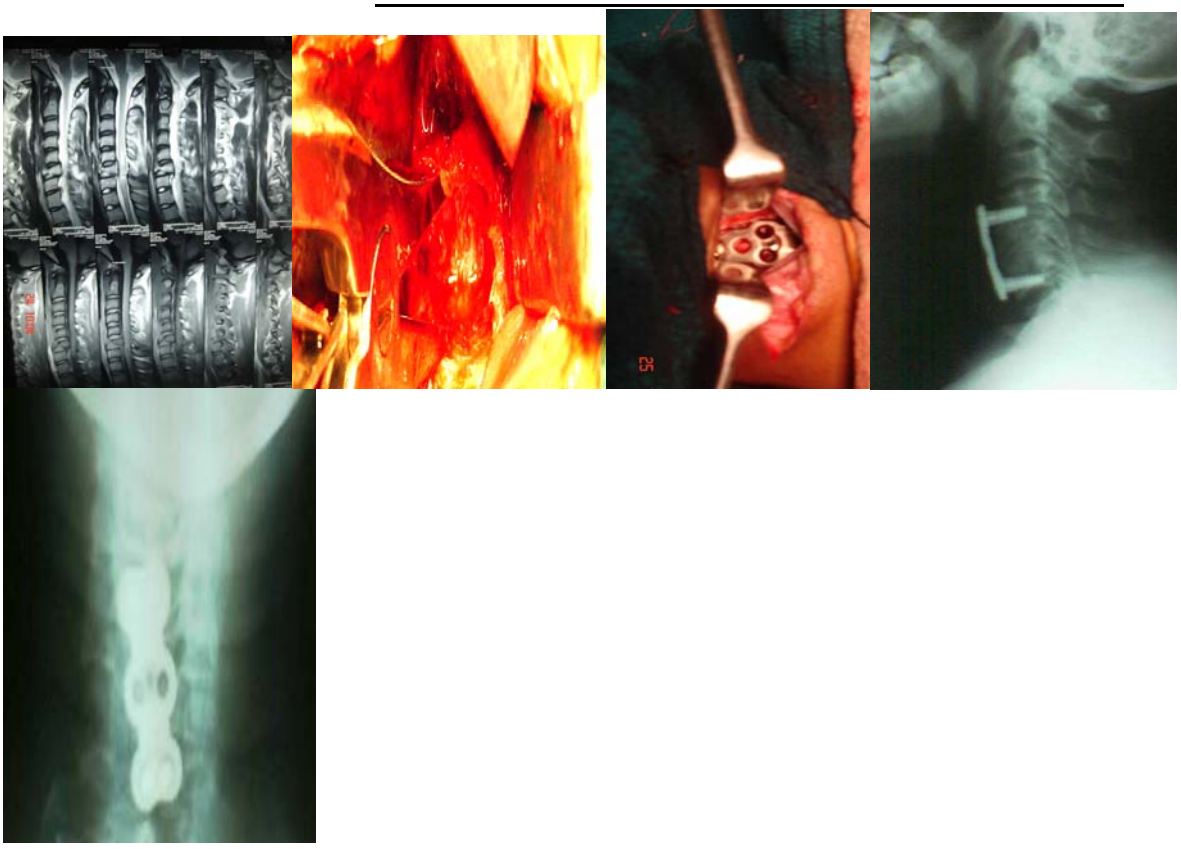
Bed to wheel chair transfer
Walking training } both were allowed if muscles power allows .

CASE NO – 1

AP VIEW LAT VIEW CT SCAN



ANTERIOR CERVICAL PLATING



1 yr follow up

2 yr follow up

Case no ; 2

C-4/5 SUBLUXATION MRI AFTER CLOSED REDUCTION DISC SPACE CONFIRMATION

POST OP

MUSCLE POWER

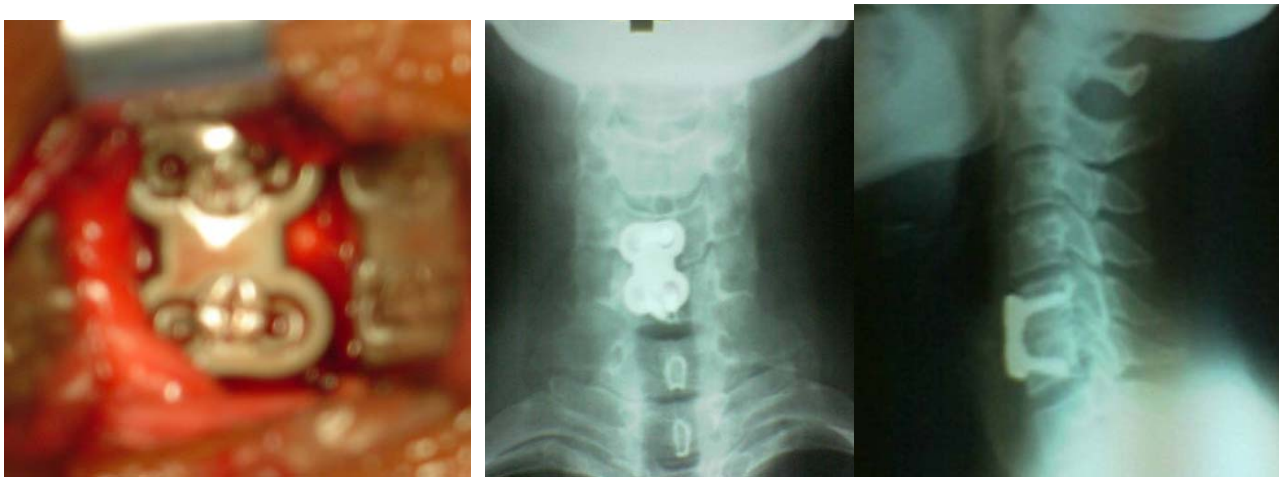
Caps plating UL POWER - 4/5 LL POWER - 4/5

CASE NO ; 3

C- 5 / C-6 SUBLUXUATION TRICORTICAL ILIAC GRAFT

INTRA OP

POST OP



1 yr follow up

2 yr follow up

CASE NO ; 4

C-3/C-4 SUBLUXUATION

C-3 /C-4 RETROLISTHESIS AP VIEW LAT VIEW



UL POWER - 4/5

LL POWER – 4/5

FLEXION

EXTENSION

CASE NO ;5

C-6/C-7 SUBLUXUATION AFTER SKULL TRACTION

MRI



POSITION CONFIRMATION

TRICORTICAL ILIAC GRAFT


ANTERIOR CERVICAL PLATING


RESULTS AND ANALYSIS

The results were evaluated on the basis of ASIA impairment scale.

Neurological evaluation was done preoperatively and at the end of 6months postopertively.

NEUROLOGICAL STATUS

PRE OP NEUROLOGY	POSTOP NEUROLOGY
ASIA GRADE A - 4	3 (1- death)
ASIA GRADE B - 6	B ⇒ C - 3 B ⇒ D - 3
ASIA GRADE C - 5	C ⇒ D - 2 C ⇒ E - 3

Complete cord lesion patients had no recovery . we had one death in complete lesion . All incomplete lesion patients are recovered well.

OBSERVATIONS AND RESULTS

Staistical analysis was done using Paired sample T test , Chisqare test ,

Descriptive and Analytical statistics .

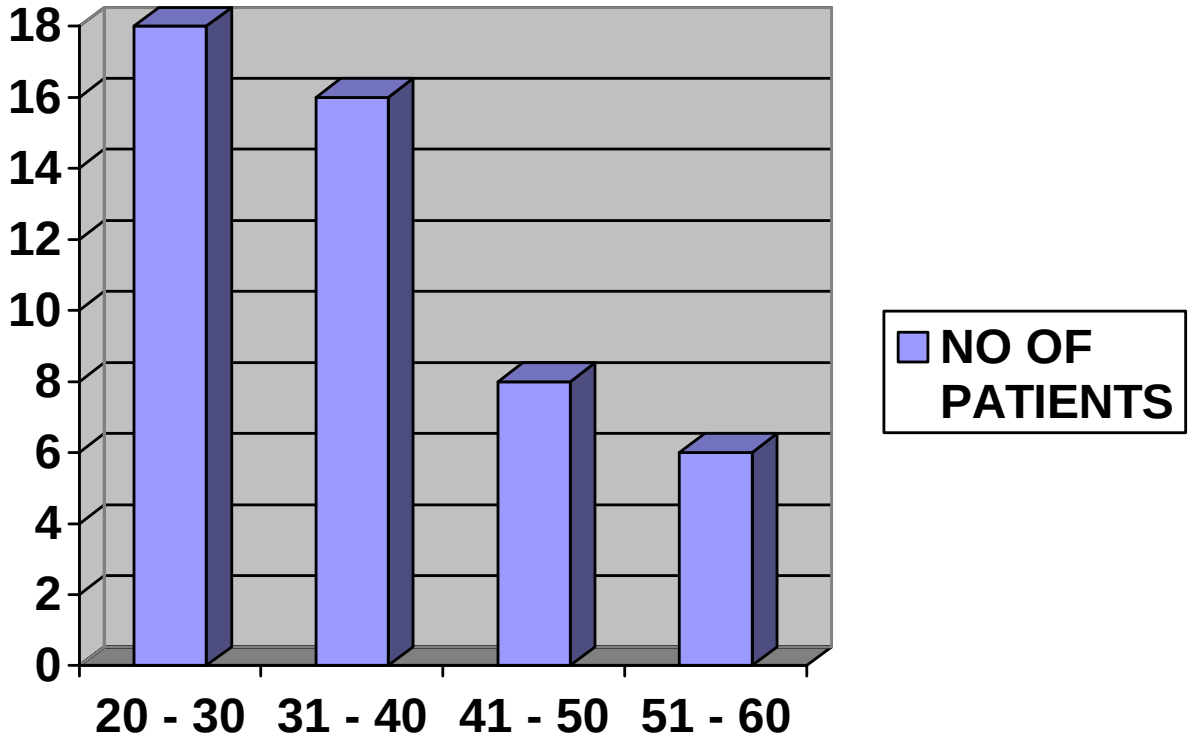


TABLE 1 : DISTRIBUTION OF AGE

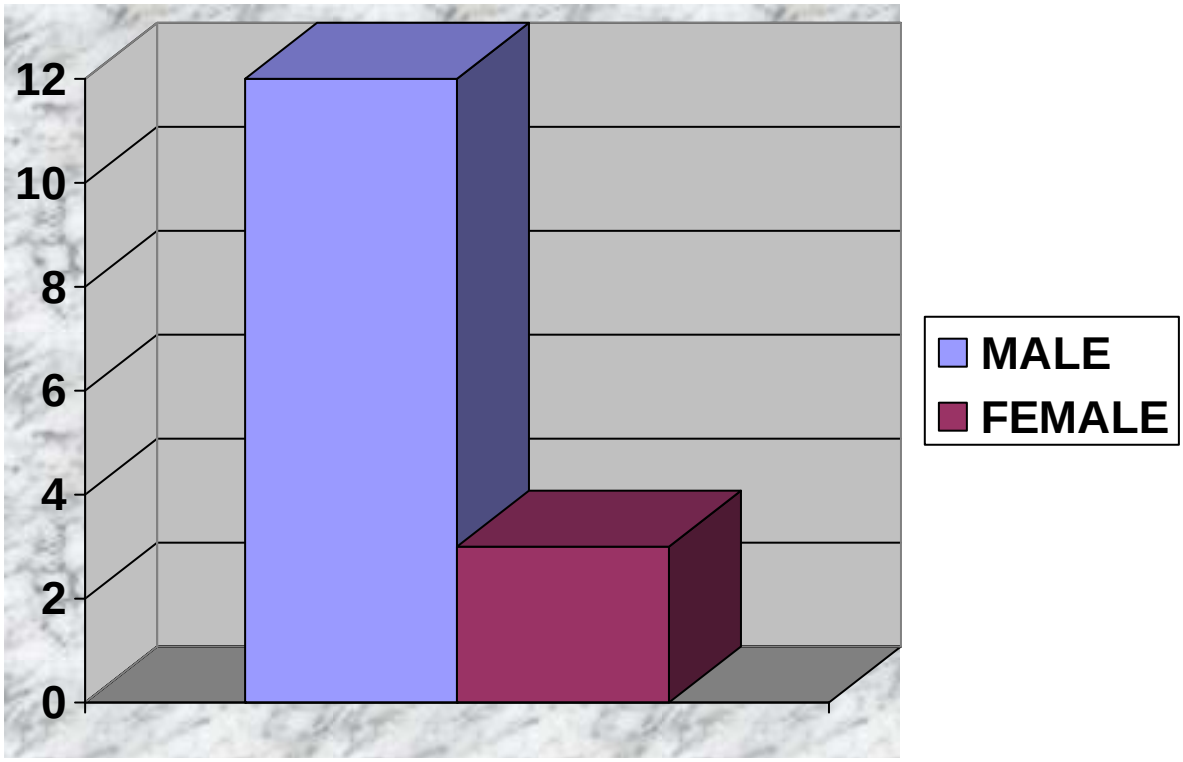
AGE	FREQUENCY	PERCENT
20 - 30	7	46.6
31 – 40	4	26.7
41 – 50	0	0
51 – 60	4	26.7
TOTAL	**15**	**100**

The most common age group was 20 -30 years with 7 (46.6 %) patients.

The minimum age - 21 years.

The maximum age - 75 years .

The mean age in our study - 41.2 years (Range21 - 75 years)


12
10
8
6
4
2
0
MALE
FEMALE

SEX	FREQUENCY	PERCENT
MALE	12	80
FEMALE	3	20
TOTAL	**15**	**100**

There were 12 males (80%) and 3 females (20 %) .

The male to female ratio was 4: 1 .

MODE OF INJURIES

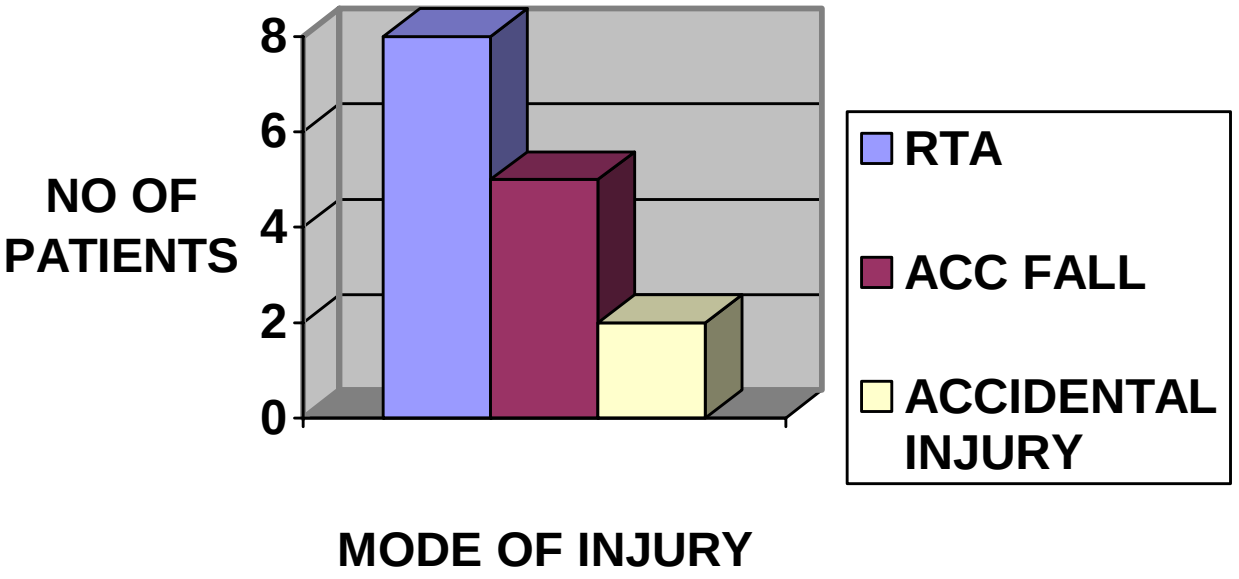


TABLE 3 : DISTRIBUTION OF MODE OF INJURIES

MODE OF INJURY	FREQUENCY	PERCENT
RTA	8	53.3
ACC.FALL	5	33.3
SLIP WHILE CARRYING WEIGHT	2	13.4
TOTAL	**15**	**100**

The most common mode of injury is Road traffic accident (53.3 %) followed by accidental fall (33.3 %) .

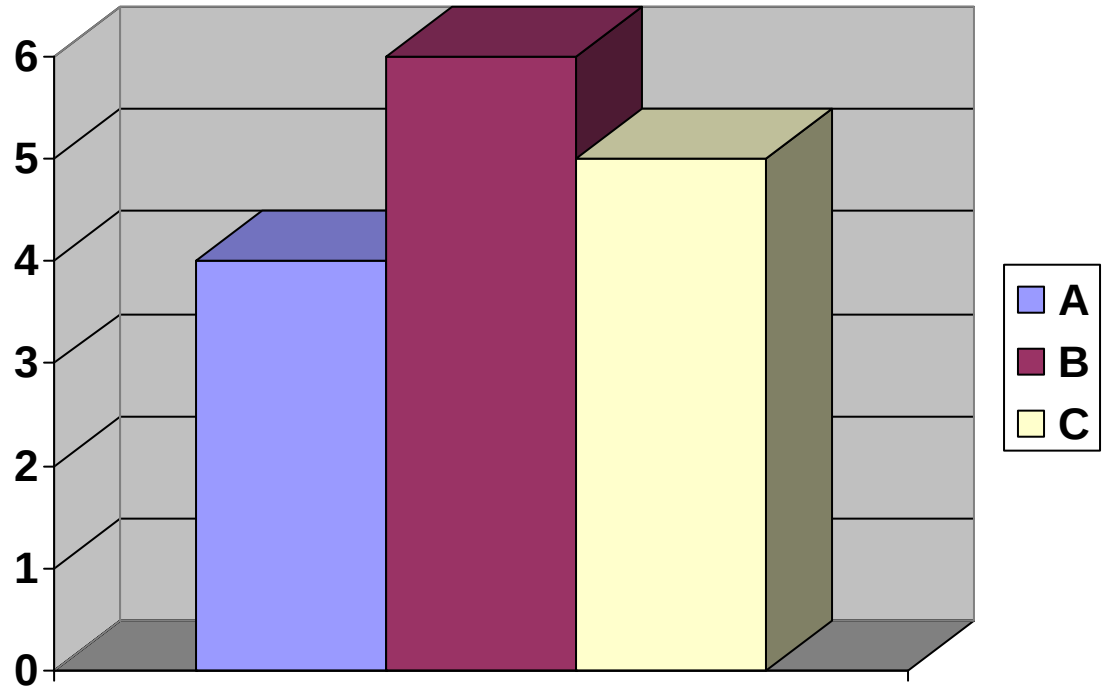

6
5
4
3
2
1
0
A
B
C

TABLE 4 : DISTRIBUTION OF TYPE OF LESIONS

TYPE OF LESION (ASIA GRADE)	FREQUENCY	PERCENT
A	4	26.7
B	6	40
C	5	33.3
TOTAL	**15**	**100**

The majority of cases in our study group are incomplete spinal cord injuries including ASIA grade B and C with 11 patients (73.3 %) . Only 4 (26.7 %) patients had Complete cord injury

TABLE 5 : DISRIBUTION OF LEVEL OF LESIONS

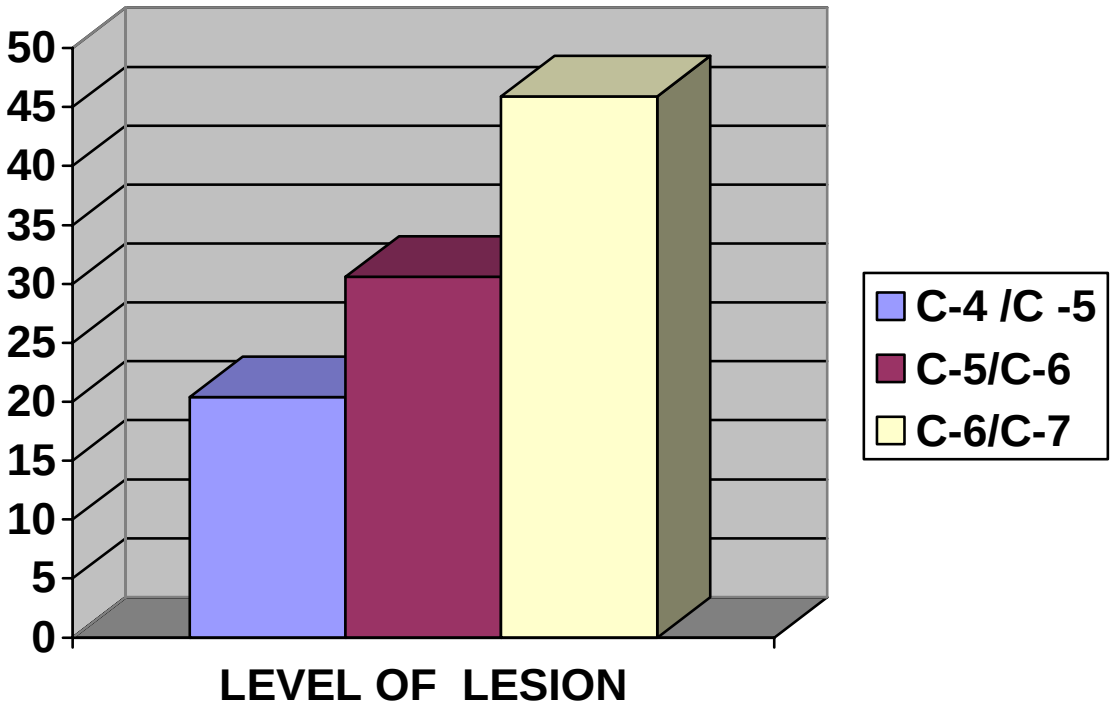


TABLE 5 : DISRIBUTION OF LEVEL OF LESIONS

LEVEL OF LESION	FREQUENCY	PERCENT
C-3 /C- 4	1	6.7
C-4/ C – 5	3	20
C-5/C-6	4	26.7
C-6/C-7	3	20
C-5 #	2	13.3
C-6 #	2	13.3
TOTAL	15	100

The most common level of injury was C-5/ C-6 (26.7%) then C-4/C-5 and C-6/ C-7 (20%) .

The least common site in our study was C-3/ C-4 (6.7%) .

TABLE 6 : NEUROLOGICAL STATUS

PRE OP NEUROLOGY	POSTOP NEUROLOGY
ASIA GRADE A - 4 (26.7 %)	3 (1- death) (20 %)
ASIA GRADE B - 6 (40 %)	B ⇒ C - 3 (20 %) B ⇒ D - 3 (20 %)
ASIA GRADE C - 5 (33.3 %)	C D - 2 (13.3 %) C ⇒ E - 3 (20 %)

There is no recovery in the complete (ASIA – A) lesion and one death in complete lesion .In incomplete lesion present 50 % ofgrade patient were recovered to C level and remaing 50% recoverd to D level . In those 5 (33.3%)patients of ASIA grade C, 2 (13.3%) patients recovered to D level and remaing 3 (20%)patients were recovered to E level.

PAIRED SAMPLES STATISTICS

	Mean	N	Standard deviation	Standard error. Mean
Pair Preop	2.07	15	0.80	0.21
1 Postop	3.20	1.52	1.52	.39

PAIRED SAMPLES CORRELATIONS

	N	Correlation	Sig.
Pair Preop & 1 Post Op status	15	.929	.000

	Paired					t	df	Sig. (2-
	Mean	Std.	Std. Mean	95% Interval of Difference				
				Lower	Upper			
Pair Pre & 1 Post op. Status	-1.13	0.83	.22	-1.60	0.67	-5.264	14	0.000

When comparing the neurological status of the patients in the pre operative and postoperative status an increase of 1.13 +_ 0.83 was observed .This observed increase in the postoperative status was found to be statistically significant by using Paired T sample test (P < 0.0005 +_ -5.264) and 95 % confidence interval was –1.60 to - 0.67) .

TABLE 7 : METHOD OF REDUCTION IN DISLOCATION OF 11 CASES

METOHD OF REDUCTION	FREQUENCY	PERCENT
CLOSED MANUPLATION	4	26.7
SKULL TRACTION	7	46.7

We had eleven cases of dislocation out of that three (27%) were reduced within twenty four hours by closed manuplation without anesthesia and eight (73%) dislocations were not reduced in that three (27 %) having bilateral facet locking which was reduced by skull traction **.** In closed manuplation cases there were no further neurological detorioration was noted.

Time Int Inj to Surgery * Postoper Status Crosstabulation

Count

		Postoper Status				
		1	3	4	5	Total
Time Int Inj to Surgery	1.000				1	1
	2.000	1				1
	3.000		1			1
	4.000				1	1
	6.000				1	1
	7.000	1				1
	8.000		1	1		2
	12.000			2		2
	13.000	1				1
	18.000		1	1		2
	20.000	1				1
	36.000			1		1
Total		4	3	5	3	15

In Chi square test the correlation between time from injury and postoperative neurological status were analysed in which P value came to be 0.284 . This P value is satistically not significant .

TABLE 8 : DISTRIBUTION OF TYPE OF SURGERY

TYPE OF SURGERY	NO FO PATIENTS	PERCENT
ANTERIOR DISCECTOMY AND FUSION	11	73.3
ANTERIOR CORPECTOMY AND FUSION	4	26.7

In our Study we done 11 (73.3%) anterior cervical discectomy and fusion using tricortical iliac graft with stabilisation by locking anterior cervical plate for dislocations .

We done 4 (26.7%) anterior corpectomy and fusion using tricortical iliac graft with stabilisation by locking anterior cervical plate for fractures .

TABLE 9 : SIZE OF TRICORTICAL ILIAC GRAFT

SIZE OF TRICORTICAL ILIAC GRAFT (in millimeters)	FREQUENCY	PERCENT
6	3	20
7	5	33.3
8	3	20
16	2	13.3
18	2	13.3

We used the tricortical iliac graft for all cases of cervical fusion with height range from 7 mm to 18 mm (Average of 9.67 mm) .

Height of the graft is small in discectomies and large in carpectomies .

TABLE 10 : MORBIDITY RATE

COMPLICATIONS	NO OF PATIENTS
BED SORE	2
URINARY TRACT INFECTION	4
SUPERFICIAL WOUND INFECTION	2
PARALYTIC ILEUS	2
DEATH	1

We had 2 cases of bed sore which were managed by flap cover and four cases developed urinary tract infection was managed by appropriate parental antibiotics and betadine bladder wash .In two cases we had superficial infection which was settled with regular dressings and antibotics we had one death in ASIA - A grade patient . Two cases developed paralytic ileus which was managed by intravenous fluids and Ryles tube aspiration .

TABLE 11 : FUSION PERIOD

FUSION PERIOD	FREQUENCY	PERCENT
6 WKS	6	40
12 WKS	4	26.7
16 WKS	2	13.3
20 WKS	2	13.3
24 WKS	1	6.7

Most of the patients in our series fusion was attained at six weeks .One patient were attain fusion at twenty four weeks.

DISCUSSION

Cervical spinal injury when associated with neurological deficit is a devasting problem leading to significant morbidity and mortality.

Controversies exist over the exact modality of treatment and timing of intervention.

All aspects of management are aimed at preventing the secondary injury to the spinal cord of which mechanical compression is one of the most important reversible factor From our study it was found that males are more commonly involved in the age group of 20 -40 years who are the most important persons socioeconomic ally.

The most common mode of violence is Road traffic accident, accidental fall from height.

Early surgery patient had earlier and better outcome and rehabilitation. Mortality rate in late surgery cases is significantly higher probably these patients are recumbent for a longer duration which may be detrimental to their cardiorespiratory status. But in our series the correlation between the timing of surgery and Post operative neurological improvement was not statistically significant .

Bailey and Badgley[1] ,Robinson and Southwick [31] et al described the importance of anterior cervical surgical stabilisation to prevent further damage when the spinal cord is injured .

Henry and Bohlman [12,40] et al reported that best recovery of neural function and restoration of stability by anterior decompression and fusion. He stated that Steroids did not improve neural recovery and their use was associated with gastrointestinal haemorrhage.

Verbeist's et al [41] finds that high mortality rate is associated with early operative treatment of completely quadriplegic patient. was reinforced by the results in our series . One complete cord injury patient (7) died in our series who was died in his home 15 days after discharge from our hospital.

In our series, anterior decompression and fusion was performed one day to thirty six days since injury with average of 11.2 days. Out of 15 cases all incomplete lesions are recovered well. These results are compared with results by Bohlman[12] et al, Cloward et al[9], and Cone, William, turner et al [42] .

Raynor et al [43] noted that severe cervical spinal injuries treated by anterior fusion and ambulation.

Forsyth, Alexander, Eben et al [44] described the importance of early cervical fusion in the fracture dislocation of cervical spine.

In our study only two patients came within eight hours since injury and they received the methylprednisolone infusion. None of them have gastrointestinal haemorrhage .

Regarding reduction Robert et al [45] stated that when dislocation is complete ,reduction must be attempted only under anesthesia and the administration of anesthesia is not a dangerous procedure . But in our series all reductions were done without anesthesia .

Brookers et al reported thirty – six successful manipulations without a death .

Barnes (1948)et al stated " skeletal traction by means of skull calipers is the treatment of choice " . Four percent of Durbin"s series of fifty three dislocations and fracture dislocations reduired open reduction .

In our series one (6.7 %) patient was underwent open reduction .

In our series of 11 dislocations , four (26.6%) were reduced by manipulation , six (40 %) were reduced by skull traction , one (6.7%)dislocation was not reducible , so we did open reduction with fusion for that patient .

The most important factor responsible for prognosis of neurological recovery were

1 . The age of the patient .

2 . Neurological status at the time of injury .

This is also confirmed in our study , in which 80 % of the patients under the age of 40 years and who were having incomplete lesion have better neurological recovery .

Patients whose MRI showing features of cord contusion have poor recovery .

CONCLUSION ;

- Cervical spinal injury occurs most commonly in the younger males who are socioeconomically important .
- Surgical decompression and fusion with stabilization improve the neurological recovery especially in incomplete cord lesions.

- Overall , the anterior cervical decompression and fusion using tricortical iliac graft is a safe procedure with high rate of pain relief , neurological recovery , and functional improvement in acute sub axial cervical spinal injuries . Grafting complications like graft failure , kyphotic deformity were reduced and fusion rate was improved by using the locking anterior cervical plating .we had no plate and screw , graft failure in our series .
- We used methylprednisolone infusion therapy for only two patients .
- Young age with incomplete lesion recovered very well.
- Given a stable spinal column with removal of impinging compression , the uninjured neural elements shall recover and give some useful motor power (or) sensory improvement in those otherwise hopless conditions .

BIBLIOGRAPHY

References

1. Baily R, Badgley C: Stabilization of the cervical spine by anterior fusion. J Bone Joint Surg Am 42:565–594, 1960.
2. Barnes B, McLauglin M, Rodts GE, Haid RW: Early results using the Atlantis anterior cervical plate system. Neurosurg Focus 12 (1):Article 13, 2002

3. Bohler J, Gaudernak T: Anterior plate stabilization for fracturedislocations of the lower cervical spine. J Trauma 20: 203–205, 1980
4. Bose B: Anterior cervical fusion using Caspar plating: analysis of results and review of the literature. Surg Neurol 49:25–31, 1998.
5. Caspar W, Barbier DD, Klara PM: Anterior cervical fusion and Caspar plate stabilization for cervical trauma. Neurosurgery 25:491–502, 1989
6. Caspar W, Geisler FH, Pitzen T, et al: Anterior cervical plate stabilization in one- and two-level degenerative disease: overtreatment or benefit? J Spinal Disord 11:1–11, 1998.
7. Chen IH: Biomechanical evaluation of subcortical versus bicortical screw purchase in anterior cervical plating. Acta Neurochir 138:167–173, 1996.
8. Cloward RB: The anterior approach for removal of ruptured cervical discs. J Neurosurg 15:602–617, 1958
9. Cloward RB: Treatment of acute fractures and fracture-dislocations of the cervical spine by vertebral-body fusion. J Neurosurg 18:201–209, 1961.

10. Connolly PJ, Esses SI, Kostuik JP: Anterior cervical fusion: outcome analysis of patients fused with and without anterior cervical plates. J Spinal Disord 9:202–206, 1996

11. DiAngelo DJ, Foley KT, Vossel KA, et al: Anterior cervical plating reverses load transfer through multilevel strut-grafts. Spine 25:783–795, 2000

12. Emery SE, Bohlman HH, Bolesta MJ, et al: Anterior cervical decompression and arthrodesis for the treatment of cervical spondylotic myelopathy. Two to seventeen-year follow-up. J Bone Joint Surg Am 80:941–951, 1998

13. Epstein NE: The management of one-level anterior cervical corpectomy with fusion using Atlantis hybrid plates: preliminary experience. J Spinal Disord 13:324–328, 2000

14. Epstein NE: The value of anterior cervical plating in preventing vertebral fracture and graft extrusion after multilevel anterior cervical corpectomy with posterior wiring and fusion: indications, results, and complications. J Spinal Disord 13:9–15, 2000

15. Griffith SL, Zogbi SW, Guyer RD, et al: Biomechanical comparison of anterior instrumentation for the cervical spine. J Spinal Disord 8:429–438, 1995

16. Grubb MR, Currier BL, Shih JS, et al: Biomechanical evaluation of anterior cervical spine stabilization. Spine 23:886–892, 1998

17. Kaiser MG, Haid RW Jr, Subach BR, et al: Anterior cervical plating enhances arthrodesis following discectomy and fusion with cortical allograft. Neurosurgery (In press)

18. Katsuura A, Hukuda S, Imanaka T, et al: Anterior cervical plate used in degenerative disease can maintain cervical lordosis. J Spinal Disord 9:470–476, 1996

19. Kostuik JP, Connolly PJ, Esses SI, et al: Anterior cervical plate fixation with the titanium hollow screw plate system. Spine 18: 1273–1278, 1993

20. Lowery GL, McDonough RF: The significance of hardware failure in anterior cervical plate fixation. Patients with 2- to 7-year follow-up. Spine 23:181–187, 1998

21. Mayr MT, Subach BR, Comey CH, et al: Cervical spinal stenosis: outcome after anterior corpectomy, allograft reconstruction, and instrumentation. J Neurosurg 96 (Spine 1):10–16, 2002

22. Morscher E, Sutter F, Jenny H, et al: Die vordere Verplattung

der Halswirbelsaule mit dem Hohlschrauben-Plattensystem aus Titanium. Chirurg 57:702–707, 1986

23. Orozco Delclos R, Llovet Tapies R: Osteosintesis en las lesions traumaticas y degeneratives de la columna vertebral. Revista Traumatol Cirurg Rehabil 1:45–52, 1971 (Reference unverified)

24. Panjabi MM, Isomi T, Wang JL: Loosening at the screw-vertebra junction in multilevel anterior cervical plate constructs. Spine 24:2383–2388, 1999

25. Paramore CG, Dickman CA, Sonntag VK: Radiographic and Clinical follow-up review of Caspar plates in 49 patients. J Neurosurg 84:957–961, 1996

26. Raveh J, Stich H, Sutter F, et al: Use of titanium-coated hollow screw and reconstruction plate system in bridging of lower jaw defects. J Oral Maxillofac Surg 42:281–294, 1984

27. Rechtine GR, Cahill DW, Gruerenberg M, et al: The synthes cervical spine locking plate and screw system in anterior cervical fusion. Tech Orthop 9:86–91, 1994

28. Rengachary SS, Sanan A: Anterior stabilization of the cervical spine using locking plate systems, in Wilkins RH, Rengachary SS (eds): Neurosurgery. New York: McGraw-Hill, 1996, pp 2983–2986

29. Richman JD, Daniel TE, Anderson DD, et al: Biomechanical evaluation of cervical spine stabilization methods using a porcine model. Spine 20:2192–2197, 1995

30. Schultz KD Jr, McLaughlin MR, Haid RW Jr, et al: Singlestage anterior-posterior decompression and stabilization for complex cervical spine disorders. J Neurosurg 93 (Spine 2):
214–221, 2000

31. Smith GW, Robinson RA: The treatment of certain cervical spine disorders by anterior removal of the intervertebral disc and interbody fusion. J Bone Joint Surg Am 40:607–624,
1958 (Reference unverified)

32. Spivak JM, Chen D, Kummer FJ: The effect of locking fixation screws on the stability of anterior cervical plating. Spine 24:
334–338, 1999

33. Suh PB, Kostuik JP, Esses SI: Anterior cervical plate fixation with the titanium hollow screw plate system. A preliminary report. Spine 15:1079–1081, 1990

34. Swank ML, Lowery GL, Bhat AL, et al: Anterior cervical allograft arthrodesis and instrumentation: multilevel interbody grafting or strut graft reconstruction. Eur Spine J 6:138–143,

1997

35. Wang JC, McDonough PW, Endow K, et al: The effect of cervical plating on single-level anterior cervical discectomy and

fusion. J Spinal Disord 12:467–471, 1999

36. Wang JC, McDonough PW, Endow KK, et al: Increased fusion rates with cervical plating for two-level anterior cervical discectomy and fusion. Spine 25:41–45, 2000

37. Wang JC, McDonough PW, Kanim LE, et al: Increased fusion

rates with cervical plating for three-level anterior cervical discectomy and fusion. Spine 26:643–647, 2001

38. White AA III, Southwick WO, Deponte RJ, et al: Relief of pain

by anterior cervical-spine fusion for spondylosis. A report of

sixty-five patients. J Bone Joint Surg Am 55:525–534, 1973

Manuscript received November 16, 2001.

39 . ARENA et al Extrusion of an intervertebral Disc associated with traumatic subluxation or Dislocation of the Cervical facets .

40 . HENRY AND BOHLMAN et al Anterior Cervical Discectomy and Arthrodesis for cervical radioculopathy; Long term follow up of one hundred and clinical results . J.Bone and Joint Surg.,1992 ; 75 ; 1298-1307 .

41 . VERBEIST ‘ S et al ; Anterolateral operation for Fractures and Dislocations in the middle and lower parts of cervical spine.Reports of a series of Forty – seven cases . J.Bone and Joint Surg.,51-A:1489-1530,Dec 1969.

42 . CONE ,WILLIAMS ,TURNER et al ,W . G ; The treatment of Fracture – Dislocations of the cervical vertebrae by the skeletal traction and fusion . J . Bone and Joint Surg ., 19; 584-602,JULY 1937

43 . RAYNOR RB , Anterior and Posterior approach to the cervical spine ; An anatomical and Radiological evaluation and comparison . Neurosurgery 1983;12;7-13 .

44 . FORSYTH , ALEXANDER , EBEN et al

45 . ROBERT et al Neurological deterioration after Reduction of cervical subluxation . . J . Bone and Joint Surg., Br 1992 ;74;224-227

46 . Vaccaro AR ,Dougherty RJ , Sheeghan TP ,et al . Neurological Out come of early Vs Late surgery for cervical spinal cord injury . Spine 1997 ; 22 ; 2609 – 2613 .

APPENDIX - I

American Spinal Injury Association

Score

APPENDIX - II

CONSENT PROFORMA

TITLE : Treatment of subaxial spinal injuries By anterior Cervical decompression and fusion with stabilization using locking anterior cervical plating .

AIM : To evaluate the functional outcome of anterior cervical decompression and fusion with stabilization using locking anterior cervical plating .

CONSENT : I have been explained about the nature of the study and also about nature of the spinal injury and the spinal surgery in my vernacular language .

signature

APPENDIX - III

CLINICAL PROFORMA

Name :

Age :

Sex :

Address :

Mechanism of injury :

Time of injury :

Level of lesion :

Time from Injury to Decompression :

Method of Reduction :

Operative Procedure :

Post operative protocol :

Rehablitation

Graft size (mm) :

Fusion Period (wks) ;

Neurological status

ASIA Score

Pre operative ;

Post operative :

Total duration of follow up :
(wks)

Complications

1. **Bed Sore**
2. **Urinary tract infection**
3. **Paralytic ileus**
4. **Superficial wound infection**
5. **Death**

APPENDIX - IV

KEY TO MASTER CHART

M - Male

F - Female

RTA - Road Traffic Accident

ACC . FALL - Accidental fall

C - Cervical vertebral level

MR - Manuplative Reduction

ST - Skull Traction

A, B,C ,D,E - American Spinal Injury Association Scores UTI - Urinary Tract Infection

MASTER CHART

S.NO	NAME	AGE/SEX	MECHANISM OF INJURY	LEVEL OF INJURY	TIME FROM INJURY TO DECOMPRESSION	OPERATIVE PROCEDURE	REDUC

1	PALANSAMY	30/M	CAPSAISED AUTO RTA	C-4/C-5	12 DAYS	C-4/C-5 FUSION	MR
2	BALASUBRAMANIAN	24/M	Acc fall	C-5 body#	8 DAYS	C-5 CARPECTOMY C-4/C-6 FUSION	-
3	MURGANANTHAM	40/M	ACC FALL	C-4/C-5	36 DAYS	C-4/C-5 DISCECTOMY & FUSION	ST
4	SENTHIL	21/M	SLIP WHILE CARRYING WT	C-6 BODY#	18 DAYS	C-6 CARPECTOMY C-4/C-6 FUSION	-
5	RAJA	26/M	ACC FALL	C-4/C-5	20 DAYS	C-4/C-5 DISCECTOMY & FUSION	ope redut
6	MARIAPPAN	36/M	ACC FALL	C-5/C-6	12 DAYS	C-5/C-6 DISCECTOMY & FUSION	MR
7	AMAL RAJ	28/M	RTA	C-6/C-7	13 DAYS	C-6/C-7 DISCECTOMYY	MR

8	SENTHIL	30/M	SLIP WHILE CARRYING WT	C-3/C-4	18 DAYS	C-3/C-4 DISCECTOMY	ST
9	MATHIALAGAN	35/M	RTA	C-6/C-7	4 DAYS	C-6/C-7 DISCEECTOMY & ,FUSION	ST
10	THANGARAJ	55/M	RTA	RETROLISTHESIS C-5/C-6	8 DAYS	DISCECTOMY & C-5/6 FUSION	
11	LAXMIKANTHAN	75/F	RTA	C-6/C-7	6 DAYS	DISCETOMY & FUSION	MR
12	MARUDHANAGAM	40/M	RTA	C-5/6	3 DAYS	DISCECTOMY & FUSION	ST
13	VAIJAYANTHI	38/F	RTA	C-5/C-6	1 DAY	DISCECTOMY & FUSION	ST
14	POONGODHAI	28/F	RAILWAY RTA	C-6 #	2 DAYS	C-6 CORPECTOMY & FUSION	-
15	SURESH BABU	17/M	ACC.FALL	C-5 #	7 DAYS	C-5 CORPECTOMY & FUSION	-
16	RAMALINGAM	72/M	ACC FALL FROM BED	C-5/C-6	3 DAYS	C-5/C-6 FUSION	